Space Weather Technical Forecast

Issued on Tuesday, 25 April 2023 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Waning CME effects with G1-G2 Minor-Moderate Storm risk Day 1 (25 Apr), further CME possible Day 2 into Day 3 (26-27 Apr) with G1-G2 risk again. Slight chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout. Chance of Active fluence.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours, with only minor C-class flares observed. There are currently seven sunspot regions on the visible disc. AR3282 approaching the northwest limb is the largest region but is no longer fully visible, so the current classification will be maintained as it rotates off. AR3285 in the southeast is the second largest region and remains generally stable. The remaining sunspot regions are all generally small and simple, the exception being the new AR3287 developing quickly to southeast of AR3285. This region has two relatively large umbra given there is very little penumbra, and further development will be closely monitored.
A filament eruption occurred from near south centre disc, starting around 24/1300 UTC. The CME has been observed in coronagraph imagery heading mostly south, but an Earth directed component is possible, with this potentially reaching Earth early on 27 April. Assessment is still ongoing.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, showed ongoing CME effects after the arrival at 23/1700 UTC. The wind speed was initially elevated but soon reached strong levels, peaking at 630 km/s, then eased back to slightly elevated levels near 470 km/s. The density was initially below average, soon increasing to above average, then slowly declining back to average levels. The IMF was initially strong or very strong with a peak of 34nT observed at 24/0105 UTC as we entered the magnetic cloud associated with the CME. IMF has since declined back to moderate levels. The north-south component (Bz) was initially strongly variable, then falling to very strong negative levels, with a minimum of -33nT observed at 24/0106 UTC. It rotated to become strongly positive during the day, and is now moderately positive. The phi angle was mostly negative (towards the Sun). Geomagnetic activity started the period at G3-G4 Strong to Severe Storm (Kp 7-8) levels until 24/0900 UTC, gradually easing, and is now at Quiet to Unsettled levels.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, started the period slightly above background levels after the CME arrival, but soon subsided to background. High energy electron flux (greater than 2MeV) as measured at GOES16, started at background levels but rose to become moderate. The associated 24-hour electron fluence was below the Active threshold on a rising trend, with 9.43e6 integrated pfu observed at 25/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is most likely to remain Low, with a slight chance of becoming Moderate.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: Earth is currently experiencing impacts from the CME which left the Sun on 21 Apr, with solar winds currently at elevated levels. Another filament eruption has occurred from near south centre disc. An Earth directed component is possible, with this potentially reaching Earth either late on 26 April or early on 27 April. Solar winds are likely to gradually ease through Day 1 (25 Apr), probably becoming near ambient during Day 2 (26 Apr) as the current CME effects wane. A HSS from CH96/- is likely to arrive during Day 2 which is similar to persistence, with wind speeds up to 550-600 km/s.
Geomagnetic activity is currently muted due to a northward oriented magnetic field, however further G1-G2/Minor-Moderate Storm intervals are possible if it rotates southwards again, perhaps mainly when Earth exits the CME influence. Activity is then expected to be mostly Quiet to Unsettled by Day 2, until the potential CME/HSS arrivals later Day 2 or early Day 3, when activity may increase once again to become Active to G1/Minor Storm, with a slight chance of G2/Moderate Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is most likely to persist at background levels, although there is a slight chance of S1 or greater, either due to the recent filament eruption or any significant flares. High energy (greater than 2MeV) electron flux is currently at moderate levels, with a rise possible through Days 1 and 2 (25-26 Apr), before a probable decline through Days 3 and 4 (27-28 Apr). Electron fluence is likely to rise at first, with a chance of reaching Active (1e8 integrated pfu), probably declining again later in the period.

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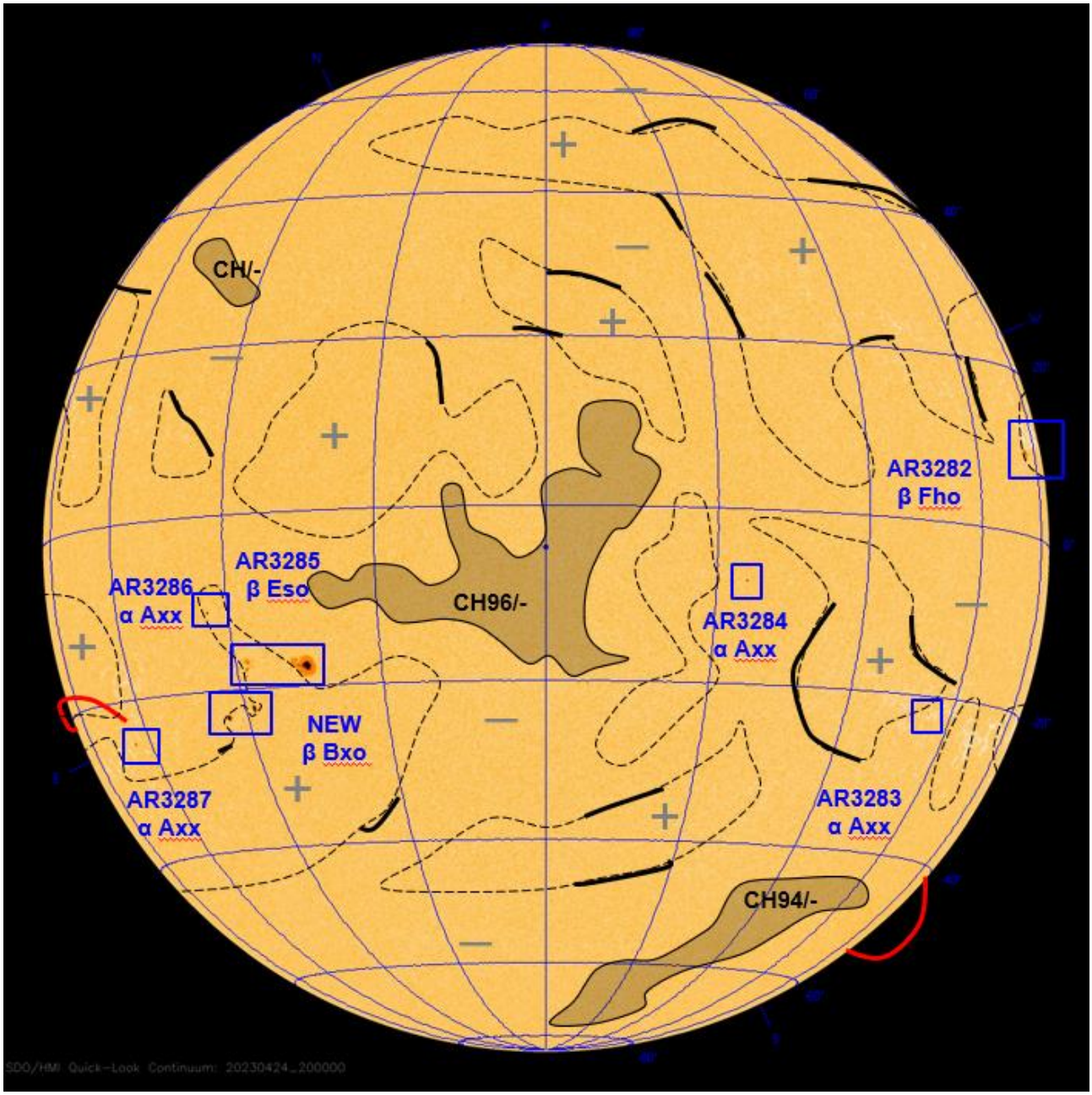
Figure 1. Solar Analysis Valid 24/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Earth is currently experiencing the impacts from the full halo CME which left the Sun on 21 Apr, with solar winds currently at elevated levels. Another filament eruption has occurred from near south centre disc, starting around 24/1300 UTC. The CME has been observed in coronagraph imagery heading mostly south, but an Earth directed component is possible, with this potentially reaching Earth early on 27 April. Assessment is still ongoing, and the probability of arrival has been spread between late on the 26 April and early on 27 April.

Solar winds are likely to gradually ease through Day 1 (25 Apr), probably becoming near ambient during Day 2 (26 Apr) as the current CME effects wane. A HSS from CH96/- is likely to arrive during Day 2 which is similar to persistence. The leading edge of this feature is similar to the last rotation, however, it is a larger feature than last time, so wind speeds around 550-600 km/s seem reasonable. That said, the HSS may be somewhat superseded by the possible arrival of the CME from 24 April - indeed, the two may become mixed up together.

Geomagnetic activity is currently muted due to a northward oriented magnetic field, however further G1-G2/Minor-Moderate Storm intervals are possible if it rotates southwards again, perhaps mainly when Earth exits the CME influence. Activity is then expected to be mostly Quiet to Unsettled by Day 2, until the potential CME/HSS arrivals later Day 2 or early Day 3, when activity may increase once again to become Active to G1/Minor Storm, with a slight chance of G2/Moderate Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	30	50	10
Strong	G3	Yes	1	1	5	1
Severe	G4	Yes	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
24/1900	Partial	Filament eruption	SW	750 km/s	27/0000 UTC	Glancing blow possible.

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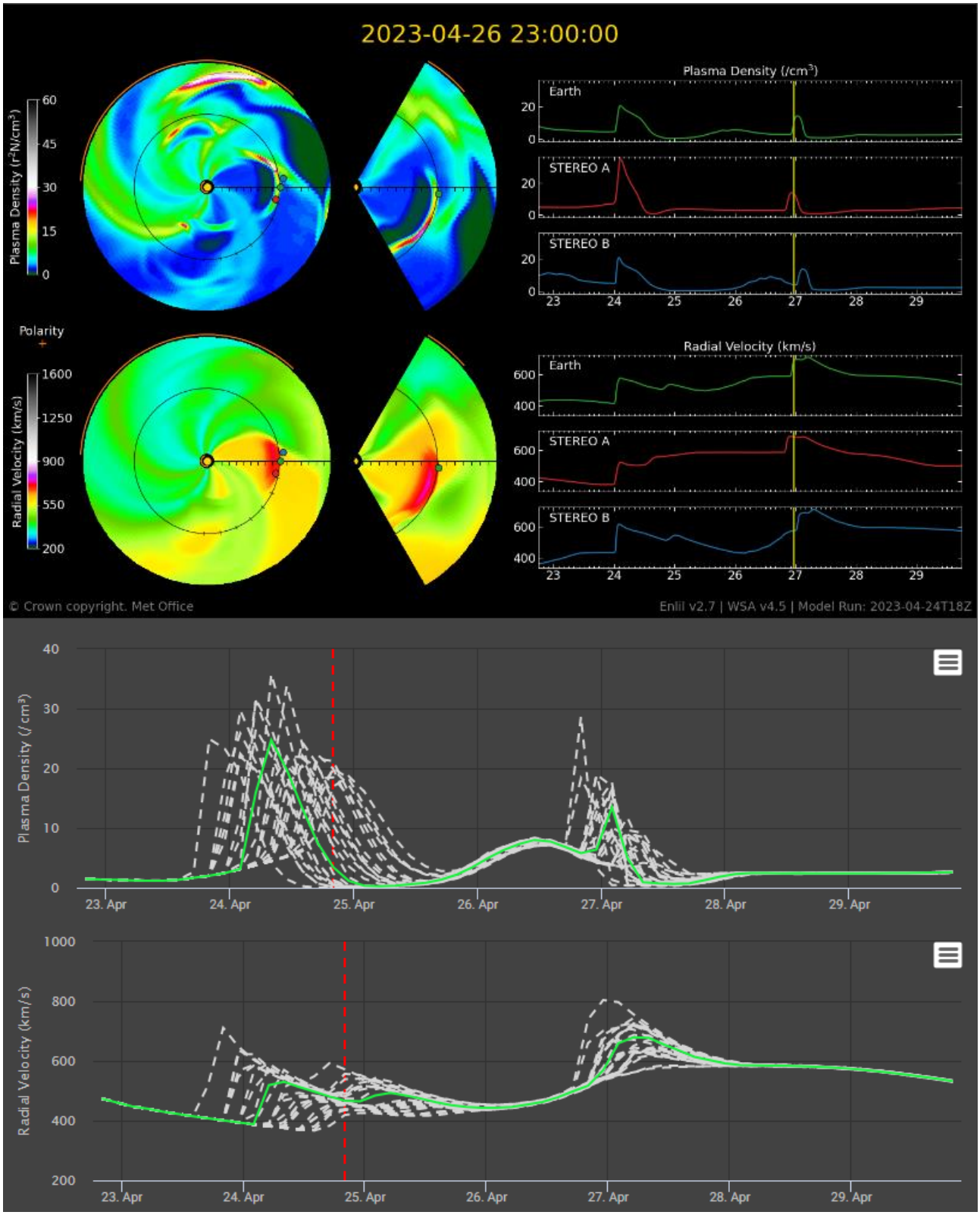
Figure 2: MOSWOC Enlil and ensemble showing a possible CME glancing blow on 26-27 April, although the bulk of the ejecta will pass below Earth's orbit.



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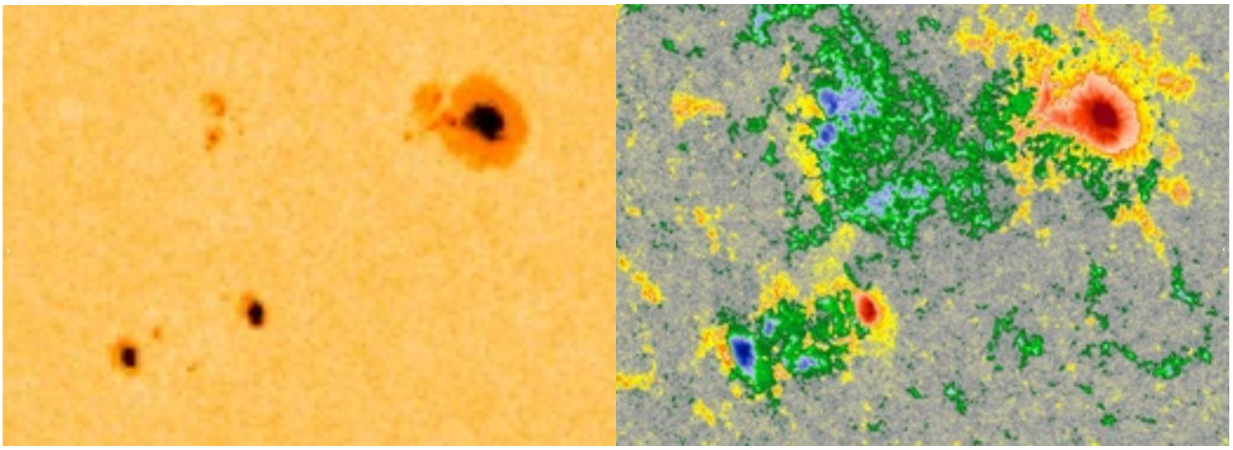
Radio Blackouts - X-Ray Flares:
There are currently seven sunspot regions on the visible disc. AR3282 (Fho/Beta) approaching the northwest limb is the largest region on the disc but is no longer fully visible, so the current classification will be maintained as it rotates off. AR3285 (Eso/Beta) in the southeast is the second largest and remains generally stable. The remaining sunspot regions are all generally small and simple, the exception being the new AR3287 developing quickly to southeast of AR3285. This region currently has two relatively large umbra given there is very limited penumbra, and further development will be closely monitored.

Far side imagery is indicating some weak active regions could rotate across the eastern limb during the period with a possible increase in flare risk. However, any increase in flare risk cannot really be assessed until they become visible, and is also balanced by the departure of AR3282 through Day 1 (25 Apr). Overall solar activity is likely to remain Low, with a slight chance of becoming Moderate with any isolated M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SDO intensitygram and magnetogram, showing AR3285 with newly developed AR3287 to the southeast.



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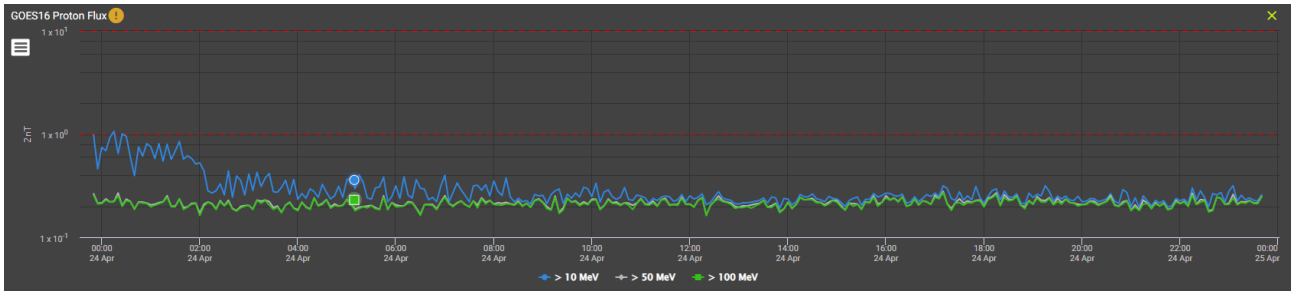
Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV), as observed by GOES16, has now returned to background levels after a brief peak when the CME arrived. There is a slight chance of reaching the S1/Minor Storm level, mainly due to AR3282, and any effects from the most recent filament eruption, but the risk reduces through the period as AR3282 will rotate well away from the west limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	3
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES16 proton flux levels have now returned to background.



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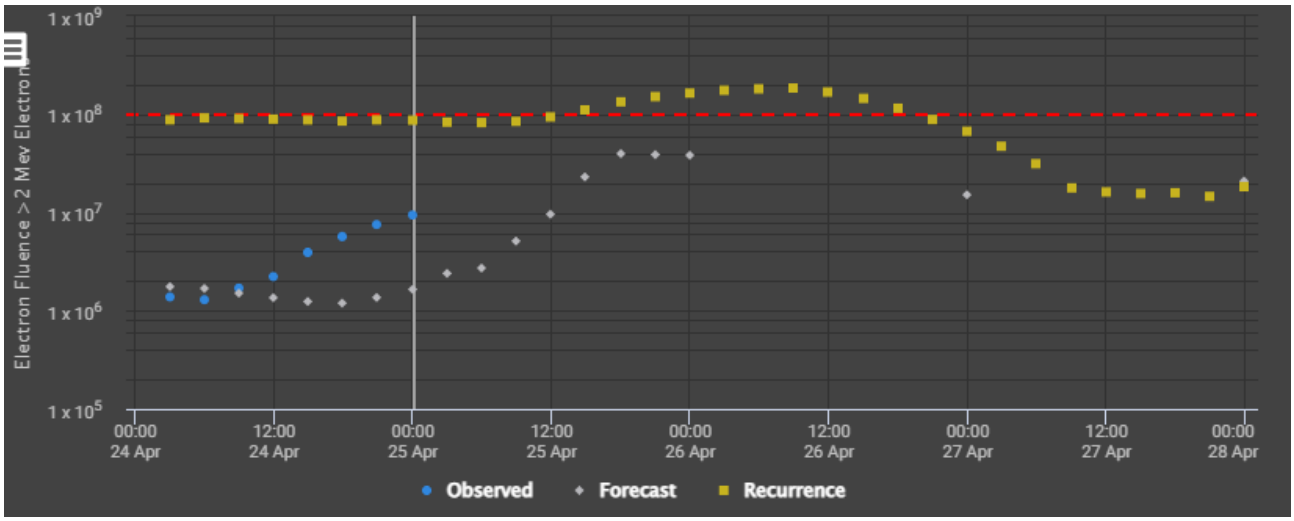
High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2MeV) electron flux reached moderate levels at the diurnal peak today. The BAS radiation belt model is suggesting that electron density has increased in the radiation belt from the recent CME effects. As wind speeds ease, it is likely that the radiation belt will relax towards GEO, carrying the increased density and causing an increase in electron flux at GOES-16. However, a further possible CME/HSS combination (see Geomagnetic Storm section) from Day 2 into Day 3 (26-27 Apr) is likely to suppress levels once again. Flux may reach moderate to high levels at the diurnal peak in the next couple of days, but is more likely to be lower later in the period.

The associated 24-hour integrated fluence is likely to show a rising trend through Days 1 and 2 (25-26 Apr), with a chance of reaching Active (1e8 integrated pfu), followed by a decline through Days 3 and 4 (27-28 Apr). MOSWOC REFM is suggesting a rise just below Active, which seems like a reasonable guide for the first couple of days, although it won't be taking into account any CME/HSS arrival during Days 2 or 3.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	30	50	30	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM forecasting an increase below Active (1e8 integrated pfu) which is reasonable, at least in the short term.



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